

Claims

[c1] What is claimed is:

1.A method for fabricating a bottle-shaped trench for DRAM devices, comprising:

providing a substrate having thereon a pad layer;

etching said pad layer and said substrate to form a deep trench having a vertical sidewall and bottom surface;

depositing a conformal silicon nitride protection layer on said vertical sidewall and bottom surface of said deep trench;

ion bombarding an upper portion of said silicon nitride protection layer;

selectively etching away said ion bombarded upper portion of said silicon nitride protection layer to expose an upper portion of said vertical sidewall of said deep trench, wherein remaining said silicon nitride protection layer constitutes a silicon nitride hard mask protecting a lower portion of said deep trench;

oxidizing said exposed upper portion of said vertical sidewall of said deep trench thereby forming a collar silicon oxide layer above said silicon nitride hard mask;

selectively etching away said silicon nitride hard mask;

and

using said collar silicon oxide layer as an etch mask to isotropic etching said vertical sidewall and said bottom surface of said deep trench that are not covered by said collar silicon oxide layer, thereby forming a bottle-shaped deep trench.

[c2] 2.The method according to claim 1 wherein said upper portion of said silicon nitride protection layer is ion bombarded with inert gases.

[c3] 3.The method according to claim 2 wherein said inert gases comprise argon and nitrogen.

[c4] 4.The method according to claim 1 wherein said upper portion of said silicon nitride protection layer is ion bombarded with title angle.

[c5] 5.The method according to claim 1 wherein said upper portion of said silicon nitride protection layer is ion bombarded with a title angle of about $3^{\circ}\sim 7^{\circ}$ relative to an axis that is perpendicular to a main surface of said substrate.

[c6] 6.The method according to claim 1 wherein said upper portion of said silicon nitride protection layer is ion bombarded with bombardment energy of about 20KeV.

[c7] 7.The method according to claim 1 wherein said upper

portion of said silicon nitride protection layer is ion bombarded with a bombardment dose of about $1\text{E}15\sim 1\text{E}16$ atoms/cm².

- [c8] 8.The method according to claim 1 wherein said pad layer is etched during the etching of said deep trench, thereby forming an annular recess, and wherein said silicon nitride protection layer fills said annular recess.